

THORNDIKE MEMORIAL LABORATORY

Second and Fourth Medical Services

Harvard Medical Unit

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A Study of Physiological Mechanisms and Inter-Relations between  
Systemic and Regional Blood Volume, Blood Flow and Electrolyte Balance.

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INTERIM PROGRESS REPORT

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(1) Renal Hemodynamics, Sodium Excretion, and Extracellular Volume

Studies have been continued in the dog to investigate further a possible role of renal blood flow per se in the regulation of sodium excretion and extracellular and vascular volume. One study demonstrating an inverse relationship between renal blood flow and sodium reabsorption (direct relationship between blood flow and sodium excretion) during salt loading has been completed, and reprints of the published article have been submitted (2). Another project demonstrating that renal vasodilatation (acetylcholine) decreases tubular reabsorption and increases sodium excretion in the absence of salt loading has been completed recently.

Currently, studies are being directed toward establishing a relationship between systemic hemodynamics and renal hemodynamics and sodium excretion. The combined role of renal vasodilatation and blood pressure in the regulation of sodium excretion is under investigation. In addition, the intermediate renal hemodynamic changes occurring between reduction in systemic hemodynamics and the known reduction in sodium excretion are being measured. Thus, pericardial tamponade and thoracic inferior vena caval constriction are known to result in sodium retention. The changes in renal hemodynamics and the tubular reabsorption of sodium occurring during these manipulations are under investigation.

(2) Effect of Change in Cardiac Rhythm Upon Excretion of a Sodium Load

As part of an inquiry into the possible role of the left atrium as a volume receptor, the response of three patients with mitral stenosis to an acute sodium load has been studied on the metabolic ward. In all three patients, excretion of the sodium load was delayed and incomplete. Two patients were successfully converted to normal sinus rhythm and re-studied.

Of these, excretion became normal in one and improved significantly in the other.

(3) Abnormal Responses of Pulse and Blood Pressure to Tilt in Patients with Mitral Stenosis

The response of heart rate and blood pressure to 60 - 70° vertical tilt was studied on 34 occasions in 26 subjects.

While five normal subjects responded normally to 70° tilt, increasing heart rate and narrowing pulse pressure, 2 patients with decompensated hypertensive heart disease and 2 with heart failure secondary to primary myocardial disease showed an abnormal response, consisting of little or no increase in heart rate and no change or increase in pulse pressure. Similar responses have previously been reported in cases of left ventricular failure by Howard and Leathart (Clinical Science 10: 521, 1951).

Of 14 studies in 11 patients with rheumatic mitral valvular disease, 6 showed a response similar to that seen in patients with left ventricular failure, consisting of little or no increase in heart rate, while pulse pressure was maintained or increased. These were mainly patients with mitral stenosis, in Class II. Inasmuch as these patients were not in left ventricular failure - most had recently been studied hemodynamically -, the data suggest that an enlarged left atrium may act as a blood reservoir maintaining normal cardiac output in the face of a vertical tilt.

Of 4 patients convalescing from pneumonia, and studied in similar fashion, 3 showed a significant increase in heart rate, but were unable to maintain their blood pressure. The fourth patient showed little increase in heart rate and a fall in blood pressure, suggesting autonomic insufficiency. These patients all had small hearts, normal central venous

pressures, and normal or low cardiac output instead of the expected hyperdynamic response to pneumonia. Diminished central blood volume in these instances may have been responsible, at least in part, for the poor tolerance of vertical tilt.

(4) Exploration of the Exercise Vectorcardiogram as a Test of Cardiac Function

It was postulated that the vectorcardiogram recorded during exercise might contain information about the functional state of the myocardium and its reserve. To test this hypothesis, Dr. Yankopoulos measured the hemodynamic response of man to two levels of supine exercise, while simultaneously recording vectorcardiographic leads. Such studies have been carried out in 12 subjects so far, including normal subjects and patients with several types of heart disease, comprising low output as well as high output failure, and hypovolemic as well as hypervolemic states. Although there was considerable variation in the hemodynamic response to exercise, which was quite definitely abnormal in a number of patients, there were no gross changes in the vectorcardiogram during exercise compared to rest. However, the data obtained are still being analyzed.

PUBLICATIONS

- (1) Akbarian, M. and Abelmann, W. H.: Observations on the hypodynamic circulatory state in patients with acute pneumonia. Clin. Res. 13: 345, 1965 (Abstract).
- (2) Earley, L. E. and Friedler, R. M.: Changes in renal blood flow and possibly the intrarenal distribution of blood during the natriuresis accompanying saline loading in the dog. J. Clin. Invest. 44: 929, 1965.
- (3) Earley, L. E. and Friedler, R. M.: Studies on the mechanism of natriuresis accompanying increased renal blood flow and its role in the renal response to extracellular volume expansion. J. Clin. Invest. 44: 1965 (November). (in press)